SCIENCE

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ELECTRICAL DEVICES OF THE MUTUAL ELECTRIC COMPANY'S SYSTEM.

IN last week's issue we presented illustrations of the Knowles dynamo and storage-battery as used by the Mutual Electric Company of Brooklyn. Several other electrical devices used by the same company are shown in the accompanying illustrations.

The Knowles meter is shown in Fig. 1. It is inserted in the main discharge circuit, and is arranged to record in lamp-hours, or, when preferred, directly in dollars and cents; so that a simple inspection will show the exact amount of current used, or its cost to the consumer. The meter is simple in construction, combining a varying electric device with a constant time device, and is not liable to get out of order under ordinary usage. It has a large range, and records equally well with low or high current strength.

A battery-charging board is shown in Fig. 2. Upon the board, as will be seen, are three switches, each between a pair of binding-posts. In operation, the 30-cell battery is connected to the binding-posts at the middle of the board, the lighting circuit to the upper pair of binding-posts, and the charging circuit to the lower pair. In charging the battery, a current of exactly the right potential to suit the requirements is secured by means of the switch at the head of the board, which throws in resistance sufficient to make the potential, as measured by a voltmeter in the charging circuit, the same as that previously found to exist between the terminals of the battery.

The Knowles current-indicator, as supplied with each dynamo, is shown at Fig. 3. It is arranged either with or without bell attachment for calling attention to excessive variation of the current. A safety cut-out, for use at the entrance of the circuit to buildings, or for loop circuits, is shown at Fig. 4. The Knowles arc-lamps, single and double, are of simple construction, and steady and positive in action. A double lamp and its mechanism are shown in Figs. 5 and 7. The form of voltmeter and ammeter manufactured and used by the Mutual Electric Company is shown at Fig. 6.

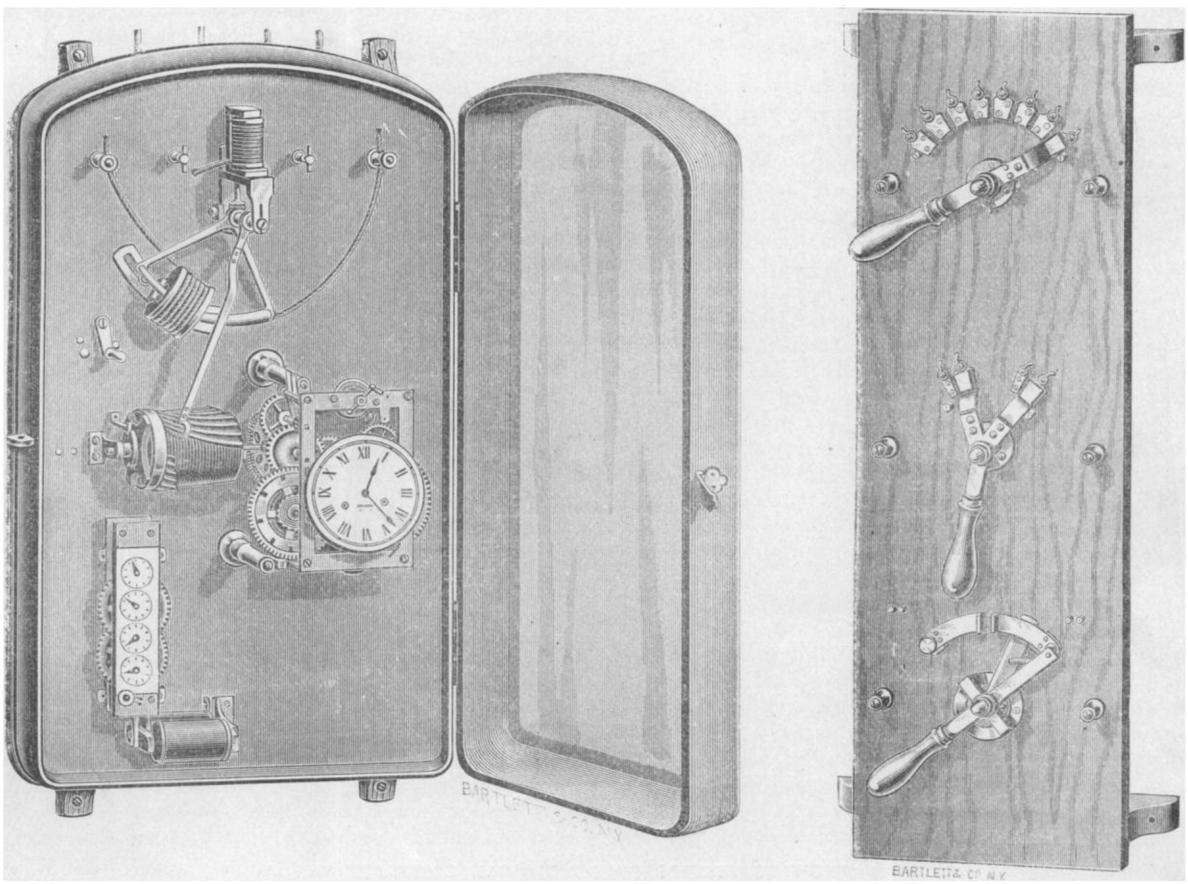


FIG. 1 AND 2.—METER AND BATTERY-CHARGING BOARD.

This company now claims to have ready for the public a complete storage-battery system, an incandescent-light system, a traction system for street-cars, a car-lighting system, an arc-light system, a combination system, and a fire-alarm system,—all worked out by Mr. Knowles, electrical engineer of the company.

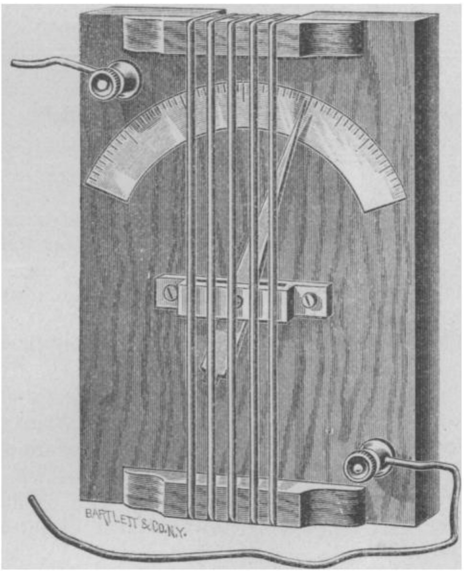
THE SPROUTING OF SEEDS.

It is well known that the germination of seeds is more or less influenced by many comparatively trivial circumstances and conditions; yet there have been no general inquiries in this country into the exact effects of these conditions, or their importance to the cultivator. Their relations to seed-testing have always seemed to Professor L. H. Bailey of the Cornell Agricultural Station to be of special importance, and it is in this direction that the investigation here referred to has been undertaken. Most of the published records of seed tests are obviously nearly valueless, because they take no account of the conditions of test. This is particularly true of those cases in which germinative vitality is recorded as low, for no assurance is given that other or more careful management might not have increased the percentages. It has been found repeatedly that a sample which gives very poor results under one treatment may give good results under another. The notes of experiments which follow may serve as suggestions to those who test: at all events, it is not too much to expect that the importance of care and uniformity in seed-testing will be emphasized. It is not to be expected that laws can be announced as the results of these somewhat discursive tests, but indications may be safely drawn in some instances.

Seed-tests are of two sorts, — the determination of the purity of the sample as regards foreign material, as weed-seeds, chaff, dirt, and the like; and the determination of the germinative vitality. The former series of tests require a simple mechanical separation of the ingredients of the sample.

Germinative vitality is commonly estimated by per cent and rapidity of sprouting.[1] Rapidity of sprouting is held to indicate vigor or strength of seed, yet the results of many tests show that it is even more influenced by conditions than is the ultimate percentage of sprouting. Causes which determine the viability and vigor of seeds are either congenital, or due to the conditions of harvesting or storing. The expression or measure of this viability and vigor is again determined by the conditions of germination. In the present investigation, with the exception of studies of the relations of weight and color to sprouting, only the conditions of germination have received attention. Seeds can be so readily selected in reference to weight and color, that it was thought advisable to study these phases of the subject in connection with conditions which may be fully controlled by the operator.

The importance of seed-testing is obvious, yet its value is ap-



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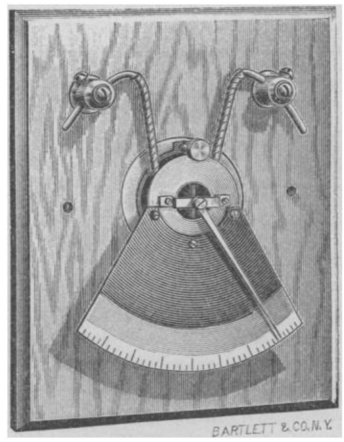


Fig. 6.

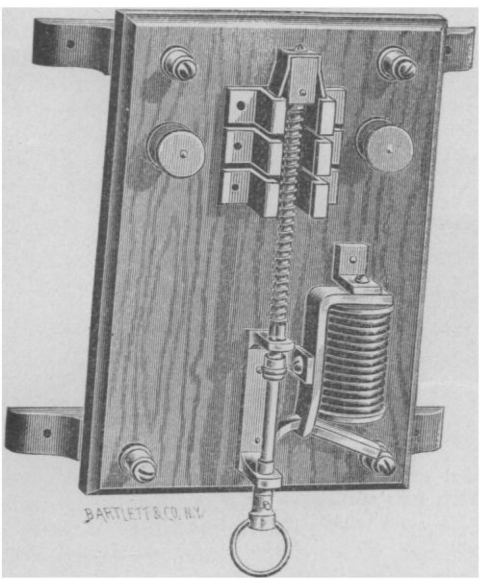


Fig. 4

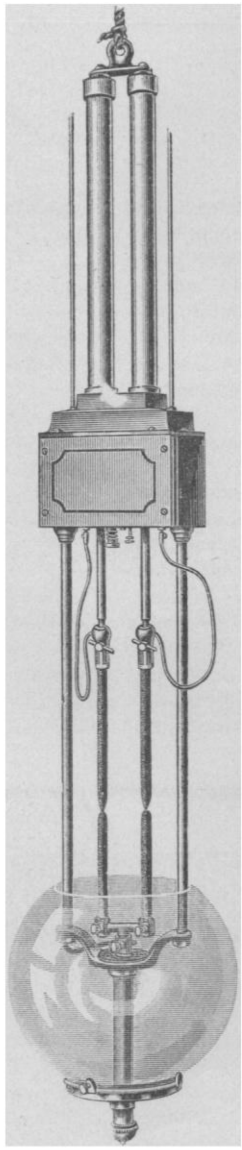


Fig. 5.

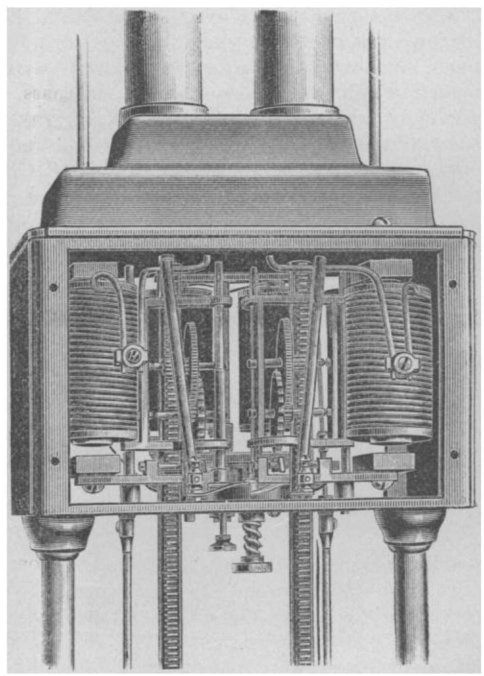


Fig. 7.

KNOWLES SYSTEM OF ELECTRICAL DISTRIBUTION.

[1] The verb "sprout" is used in preference to "germinate," as germination is complete only when the plantlet has assumed its true leaves, and has begun to assimilate. In seed-testing, the process is rarely carried to full germination.

parently commonly misapprehended. Its primary value is the determination of the vitality of a given sample. This testing, except in rare instances, should be conducted by the grower himself. The proper work for the experiment station is that of determining the best methods and conditions of testing each species and variety: in other words, it seems that the sphere of the stations is to discover and announce laws and rules, rather than to perform the petty tests for the multitude. Merely testing seeds for the purpose of determining how many will grow, is surely not experiment, and the publication of disconnected tests seems to be entirely unprofitable. The endeavor to determine the relative merits and honesty of seedsmen, by means of testing their seeds, is the merest folly.

There appears to be no necessity for seed-control stations in this country, certainly not for such seeds as fall to the hands of the horticulturist. The control stations of the Old World have sufficiently exposed the tricks of seedsmen, and have rendered open dishonesty unprofitable. There is now such sharp competition in the seed-business, that seedsmen themselves must exercise every caution in order to demand a trade. Improved methods and apparatus for harvesting and cleaning are giving us clean samples. The greatest risk in the purchase of seeds is the possibility that inferior strains or varieties may be procured; but this is a risk which the control station could not assume to govern, inasmuch as the substitution becomes apparent only when the crop is grown The experiment stations may be expected to influence sufficient control in the seed-business, as occasion shall require.

FIG. 1.

The tests enumerated in this article have been conducted with the greatest care. Unless otherwise recorded, they have been made in a steam-heated forcing-house. As a rule, they have been made in earth, in shallow earthen seed-pans. These pans are exceedingly convenient, and they afford good drainage. In some cases, lily-pans have been used, but they differ from the seed-pans only in their circular outline and somewhat greater depth. Illustrations of seed-pans may be seen in Figs. 3 to 7. For sowing seeds at uniform depths, two devices have been used. The simpler of these (Fig. 1) is nothing more than a block of half-inch stuff, two inches wide, of the required length, upon which is nailed a cleat equal in thickness to the depth of sowing. The cleat is pressed into the soil evenly, and the seeds are dropped into the furrow it makes. The other device (Fig. 2) may be called the Tracy planter. It consists of two strips of heavy tin plate nearly three inches wide, hung upon two wire pivots or hinges some two inches long. At their upper edges, and equidistant from either end, the plates are joined by a firm spiral spring, which serves to throw the upper edges apart, and to cause the lower edges to join. This trough is filled with the required number of seeds, and is then inserted into the earth to a given depth, when the fingers push inward on the spring, and the trough opens and delivers the seeds.

I. Influences of Constant and Variable Temperatures.

The tests here enumerated were made in an incubator of which the temperature was controlled by a galvanic current communicating with clock-work, and in a steam-heated forcing-house. In the incubator the temperature rarely varied three degrees, while the position of the seed-table in the forcing-house was such that variation sometimes amounted to sixty-five degrees. In some cases, duplicate tests were made in an out-door cellar which was used for the storing of nursery stock.

The conclusions from the tests — seven with beans (Green Flageolet), one with peas (White Garden Marrowfat), one with radishes (Half-Long Early Scarlet), two with turnips (Red-Top Strap Leaf), and four with onions (Giant Yellow Globe Rocca) — were as follows: —

1. Different results are obtained from the same sample of seeds under different variations of temperature, of which the daily mean is essentially the same.

2. Sprouting takes place more quickly under essentially constant temperature of about 74° than under a temperature ordinarily variable, which gives about the same mean.

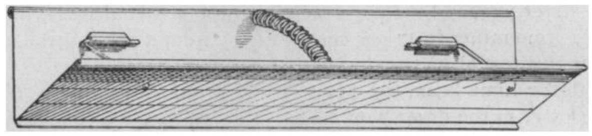


FIG. 2.

3. Rapidity of sprouting is particularly marked in beans and peas.

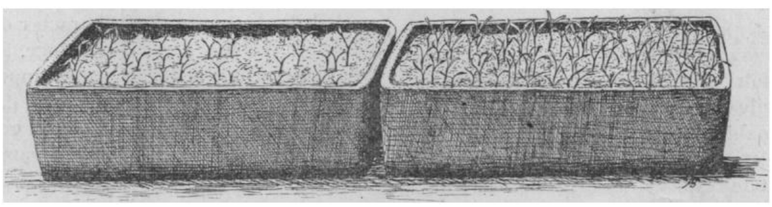
4. As the mean temperature becomes lower, rapidity of sprouting becomes slower.

5. Greater rapidity of sprouting does not appear to be correlated with greater per cent of total sprouting.

6. Constant temperature, of the degree here mentioned, does not appear to give greater percentages of sprouting: at least, the variation in this respect between the constant and variable temperatures is no greater than that which is usually obtained from tests conducted under identical conditions. In the seven tests with beans, however, there is an average gain of 5 per cent in favor of those under constant temperature.

II. Influences of Different Quantities of Water.

Mr. W. W. Tracy of Detroit, well known as an expert in the handling and testing of seeds, once said that he rarely obtained the same results from different tests of the same sample, if made in houses under the care of different men. He attributed this variation mostly to the various amounts of water habitually used by the different men. Acting upon this suggestion, a number of very careful tests have been made in weighing the amounts of water used. The results have been the most marked of any which have ever come under Professor Bailey's notice in the testing of seeds.



Wet Pan. FIG. 3. *Dry Pan.*

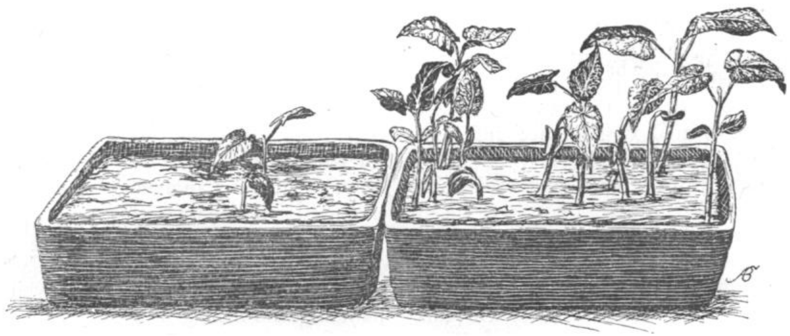
The tests were all made side by side in a forcing-house, unless otherwise recorded, in earthen pans. The soil, with one exception, was a good quality of light potting earth, containing a good admixture of field-sand. Although the pans were very shallow, extra drainage was given by the use of broken pots. The samples which received the most water were rarely wet enough to drip: in fact, they had no more water than is given in many houses. The pans sparingly watered were dryer than they would be kept in most houses. The 8-inch round lily-pans are 4½ inches deep. The 10-inch seed-pans are 2½ inches deep, and the 12-inch pans 3 inches deep.

The conclusions drawn from the tests — two with tomatoes (Green Gage), two with cucumbers (Nichol's Medium Green), one with lettuce (Boston Market), two with carrots (Vermont Butter and Early Forcing), one with celery (White Plume), one with turnips (Early Six Weeks), one with pepper (Golden Dawn), two with Lima beans (Large White), and two with *Cobœa scandens*

(Vaughan) — were, that (1) the quantity of water applied to seeds under test may make a remarkable difference in the results; (2) that sprouting is decidedly more rapid in tests which receive less than the usual amounts of water given in greenhouses (this is markedly the case in all the tests, with the exception of three indifferent and comparatively unimportant instances); (3) that the per cent of sprouting is much greater, as a rule, in the dryer tests; (4) that the addition of water above the amount to keep the earth simply moist is injurious; and (5) that the wide differences between the results of the wet and moist tests are not necessarily due to the rotting of the seeds in the wet tests (this is shown in the two tests with cucumber-seeds in which the dryer tests gave similar or even smaller totals than the wet tests).

In the tests with carrot, sprouting was remarkably more rapid in the dryer pan, and the per cent of sprouting was also very much greater, amounting to 47 per cent. Fig. 3, from a photograph, represents this test at its conclusion.

With the Lima bean, the per cent of sprouting was over 70 per cent greater in the dryer pan. This was due to the fact that more of the beans rotted in the wet pan. On May 22, twenty-six of the beans sown May 4 were rotten in the wet pan. Only six were rotten in the dryer pan, and ten were sprouting. It is known that seeds with a slight surface abrasion often germinate better than those which are uninjured; but this test indicates that great care must be exercised to water such seeds sparingly, as they are more likely to rot. Fig. 4, from a photograph, represents this test on May 20.



Wet Pan. FIG. 4. *Dry Pan.*

III. Influences of the Soaking of Seeds before Sowing.

It is a common practice in both field operations and seed-testing to soak seeds in water before sowing. Several tests made indicate very clearly the leading results of this custom. In this connection it is interesting to study results with the Geneva seed-tester, which tests seeds by soaking them. A number of tests were made with the Geneva tester in comparison with sowing in potting soil in forcing-house. The results, which are too extended to be detailed here, indicate that higher sprouting tests are given by the Geneva tester than by planting under known conditions. Ten tests in each case with Marblehead Mammoth cabbage-seeds gave an average germination of 88 per cent in the tester, against 77.6 per cent in the soil. The earliness at which the sprouting is visible in the tester renders testing expeditious; but it must be remembered that full germination cannot often be secured in the apparatus. (Cf. § IX.)

The conclusions drawn from the tests — two with carrots (Early Forcing and Vermont Butter), four with tomatoes (one Green Gage, three Belle), one with turnips (Early Six Weeks), two with radishes (Early Scarlet Globe), and one with onions (Giant Yellow Globe Rocca) — were as follows: —

1. Great gain in rapidity of sprouting, counting from the time of planting, may be expected as a rule, if seeds are previously soaked in water; and the longer the seeds are soaked, within reasonable limits, the greater is usually the gain in rapidity of sprouting, This fact is interesting, in face of the experience that very profuse watering after sowing gives an opposite result. (Cf. § II.)

2. This gain in rapidity of sprouting in soaked samples is really fictitious, however, inasmuch as germination actually begins in the soaked seeds before the dry samples are sown. In truth, the soaked seeds are sown earlier than the dry ones. If this advance in period of sowing is added to the date of sowing of the dry seeds it will be found that dry seeds as a rule sprout fully as early as soaked seeds, and many times much earlier.

3. The total amount of sprouting does not appear to be influenced by soaking.

4. Similar results are not to be expected from all species of plants.

IV. Influences of Character of Soil.

It is well known that texture of soil often has much to do with the germination of seeds in the field. Soils which bake, which become very dry, or which hold too much moisture, always tend to give a poor "stand" of crop. But the soils used in houses are such as to occasion no thought of their influence upon germination; yet there are cases in which such soils cause variation in seed-tests. This was particularly marked in a lot of beans tested this spring. Samples happened to be sown at the same time in potting soil on a bench, and under a cloth on the surface sand. Those in soil gave much poorer germinations than the others. Other sowings were therefore made from the same lot at given depths in sand for purposes of comparison. The figures cannot be presented in the limited space of this article, but it was found that sproutings were in some cases nearly twice as many in sand as in potting soil. More beans rotted in the soil than in the sand. The soil had not been sifted, and it contained some manure; yet it was only four inches deep on the bench, and it would seem that the drainage was good. Tests in this direction warrant the following conclusions: 1. Variations in results of testing may sometimes be expected in consequence of character of soil in which the tests are made; 2. In the present instance, low results in potting soil, as compared with tests in sand, appear to be due to the greater amount of water held in the earth, causing the seeds to rot. The results may therefore be studied in connection with those upon the influence of varying amounts of watering. (Cf. § II.)

V. Influences of Light.

Darwin, in his "Cross and Self Fertilization" (American edition), p. 13, says, "On other occasions, from the want of time, the seeds, instead of being allowed to germinate on damp sand, were sown on the opposite sides of pots, and the fully grown plants measured. But this plan is less accurate, as the seeds sometimes germinate more quickly on one side than on the other. It was, however, necessary to act in this manner with some few species, as certain kinds of seeds will not germinate well when exposed to the light. . . . This occurred in the plainest manner with the seeds of *Papaver vagum* and *Delphinium consolida*, and less plainly with those of *Adonis æstivalis* and *Ononis minutissima*. Rarely more than one or two of the seeds of these four species germinated on the bare sand, though left there for some weeks; but when these same seeds were placed on earth in pots, and covered with a thin layer of sand, they germinated immediately in large numbers."

Of late years there has been more or less said concerning the sowing of seeds for test upon the surface of soil, and covering with glass in order that every seed may be watched; and certain seed-testing apparatus have been devised upon this principle. It appears from Darwin's experience that with some seeds grave errors may occur from this practice, and further evidence of the

same nature is furnished from the tests here recorded. Several tests were made in which the seeds were sown upon the surface of soil in pots or pans; the pots, unless otherwise mentioned, being plunged in sphagnum moss to keep the soil moist. Over the top of the pot or pan was placed a pane of glass, or a close-fitting iron saucer or a board.

The conclusions from these tests — one with *Papaver rhœas* (English poppy), one with larkspur (Dwarf Rocket), one with *Adonis æstivalis*, and one with radishes (Early Scarlet Globe) — were as follows: —

1. Very great differences in results may sometimes be expected between samples exposed to light during the process of sprouting and those kept in darkness.

2. When such differences occur, they indicate that light retards or even wholly prevents germination.

3. In some species this influence of light is greatly marked, while in others it is not apparent.

4. It is apparent that those apparatus which test seeds by holding them on a porous plate above water are to be looked upon with distrust, unless provided with an opaque covering; and even then they may prove unsatisfactory, as the experience with the larkspur-seeds indicates that best sproutings follow planting in the soil.

VI. Weight of Seed in Relation to Sprouting.

Many experiments have been conducted this year upon the relation of weight of seed to germination, but the figures are too numerous to be recorded here. The general results of the tests may be indicated, however. Most of the work recorded in Sections VI. and VII. was performed under the direction of Professor Bailey, by Mr. B. R. Wakeman, of the class of 1889, in preparation of a thesis for graduation.

Of itself, *per se*, weight appears to exercise no influence upon germination, but it is often a tolerably accurate measure of viability as determined by various causes. Broadly stated, it may be said that comparative lightness in a seed indicates arrested growth, and consequent lowness of germinative vitality.

Fig. 5, from a photograph, illustrates a test with radish-seeds, in which the differences were marked.

It is often true that over-ripe seeds germinate more slowly, and give lower total results, than others, and this over-ripeness is sometimes indicated by additional weight. It is to be expected, therefore, that in some instances best results in germination come from the seeds of lighter weight.

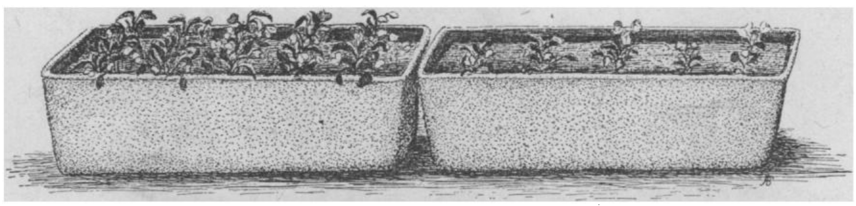
The conclusions from a number of tests — two with cabbages (one Red Dutch and one Flat Dutch), one with radishes (Early Scarlet Globe), one with beans (Improved Green Flageolet), and one with *Lathyrus sativus* (gesse), and others — were as follows: —

1. Variations in results of testing, both as regards rapidity of sprouting and the total amount, may be expected between seeds of different weights in the sample.

2. This variation is much greater in some species than in others. In these tests the variation was particularly marked in cabbage, radish, sweet pea, bean, gesse (*Lathyrus sativus*), burnet (*Poterium sanguisorba*), martynia, orach.

3. As a rule, the heaviest seeds in any sample give earliest and highest results.

4. In some cases the lightest seeds in the sample give earliest and highest results, apparently because the heaviest seeds, with which they are compared, are over-ripe; or in some instances under-maturity may result in earlier germinations, and such seeds are sometimes light in weight.



Heavy Seeds. FIG. 5. *Light Seeds.*

VII. Color of Seed in Relation to Sprouting.

Color may be assumed to indicate, in most cases, some vital character of the seed, as determined by various causes. In one species, or even in one individual sample, it may indicate a different character from what the same color does in another species or sample. It may indicate degree of maturity, method of curing, age of seed, or other peculiarity. It is to be expected, therefore, that color may sometimes designate more or less accurately the germinative vitality of the seed. It follows, however, that no general law of relation of color to germination can be announced: every species, and sometimes every sample, must be investigated for the law which governs itself. Many tests in this direction have been made, but one example will show something of the extent of variation in seeds of different colors.

With the bean (Green Flageolet), sproutings were most rapid, and higher in total per cent in the green-colored samples. This test was twice repeated with similarly marked results. The same variety from the Department of Agriculture gave opposite results, however.

Fig. 6 shows tests of white and green colored Lima beans, sown at the same time. The green-colored seeds are ahead.

Four tests with morning-glories (both *Convolvulus major* and *C. minor*) gave results uniformly in favor of white seeds as contrasted with black ones in the same sample.

From a considerable study of the importance of color in relation to germination, the following conclusions have been drawn: 1. Seeds which differ widely in color in any sample frequently give different results under test; 2. This variation in results may lie in greater rapidity of sprouting, or in higher total amounts, or in both; 3. The relative values of seeds of different colors vary with each species, or sometimes with each sample.

VIII. Influences of Latitude.

Plants of high latitudes are more sensitive to heat and cold than those of the same species growing nearer the equator; i.e., they start or vegetate relatively earlier in spring. This subject has been investigated in several directions; but, so far as the writer is aware, it has not been pursued in this couutry in relation to germination of seeds. The following tests are incidental to this investigation, being a part of a general series of researches upon the influence of latitude upon plants, but they are suggestive in this connection.

A sample of white dent corn was secured from the Alabama Experiment Station, and samples of white and yellow dents were obtained from the South Carolina Station. The germination of these samples was compared with that of corn grown on the farm of Cornell University.

With corn from different latitudes, fifty kernels in each sample, sown one inch deep in 12-inch seed-pans, sprouting was much the most rapid in the New York corn, but differences in totals were evidently not due to influence of latitude. The plants from New York seed were by far the largest and most vigorous of any in the test during the month which they remained in the house. The Alabama seed gave the least vigorous plants, while South Carolina seeds gave intermediate results. Fig. 7, from a photograph, illustrates the New York and Alabama samples ten days after sowing.

Three other tests were made, with the same result. In one test the sample from New York was represented by seed taken from a crib of soft corn, yet this sample gave earliest results, though less marked than in the other instances. A similar lesson appears to

be taught by the behavior of the seeds of species of *Carex*, which were planted this spring. Of some eighty pots of seeds, collected by Professor Bailey in Europe last year, thirteen show germination at the present time; and of these, all the most forward, with two exceptions, are northern species, collected in Scotland.

The conclusion is, that northern-grown corn appears to germinate more quickly than southern-grown corn.

IX. Variations in Duplicate Tests under Like Conditions.

It may be well to briefly call attention to the fact that scarcely any two tests made with seeds from the same sample, under conditions apparently identical, are exactly alike in results. It frequently happens that these results are so dissimilar as to give no warrant for expressing an opinion of the value of a sample from two or three tests.

The conclusions are that (1) one test cannot be accepted as a true measure of any sample of seeds; and (2) variation in duplicate tests is likely to be greater when seeds are planted in soil than when tested in some sprouting apparatus like the Geneva tester (cf. introduction to § III).

X. Comparisons of Results of Seed-Tests with Results of Actual Sowing in the Field.

It has been said recently that the ideal test of seeds is actual sowing in the field, inasmuch as the ultimate value of the seed is its capability to produce crop. This notion of seed-tests is obviously fallacious, although the statement upon which it is based is true: in other words, actual planting rarely gives a true measure of the capabilities of all the seeds of any sample, because of the impossibility to control conditions and methods in the field. The object of seed-tests is to determine how many seeds are viable, and what is their relative vigor. If planting shows poorer results, because of covering too deeply or too shallow, by exposing to great extremes of temperature or moisture, or a score of other untoward conditions, the sample cannot be held to account for the shortcoming.

Various samples were tested indoors, and actually planted in the field. The seeds were sown in the field June 5, and the last notes were taken from them July 5. They were sown on a gravelly knoll. Rain fell about every alternate day, and the soil was in good condition for germination throughout the month. The indoor tests were made in loose potting earth, or in sand in seed-pans.

The conclusions were, that (1) actual planting in the field gives fewer germinations than careful tests in conditions under control (this difference in total of germination, even under favorable conditions of planting, may amount to over 50 per cent); and (2) in planting, due allowance should be made for the comparatively bungling methods of field-practice by the use of greater quantities of seeds than would seem, from the results of tests, to be sufficient.

XI. Impurities in Samples of Garden-Seeds.

Over one hundred packages of seeds have been carefully examined for impurities, and in ninety separate instances the results have been tabulated and compared. This examination consisted in counting every seed in the sample, counting the impurities, weighing the seeds and the impurities, and determining, so far as possible, the character of the impurities. The percentages of impurities, both by number and weight, have been calculated. From these analyses it is easy to draw conclusions as to the probable extent of adulteration or impurity in garden-seeds. No evidence of adulteration was found, and weed-seeds were few and unimportant. In some cases the sample had not been properly cleaned, but in general the more important seeds were very free from impurities. The impurities were very largely immature and imperfect seeds. The average of impurities, by number, was found to be 2.76 per cent, and by weight, 1.38 per cent. The investigation appears to indicate that there is no necessity for seed-control stations in this country, for the purpose of preventing dishonesty and carelessness in the sale of garden-seeds. The detailed results will soon appear in *Agricultural Science*.

As a general summary of his results, Professor Bailey gives the following: —

I. The results of a seed-test depend very largely upon the known conditions under which the test is made.

1. Variations in temperature may cause variations in rapidity of sprouting.

2. An essentially constant temperature of about 74° gives quicker results than an ordinarily variable temperature of a similar mean.

3. It is probable that any constant temperature gives quicker results than a variable temperature of which the mean is the same as the constant temperature.

4. As the mean temperature lowers, sprouting, as a rule, becomes slower.

5. In some instances, greater rapidity of sprouting, due to a constant temperature of 74°, does not appear to be correlated with greater per cent of total sprouting. In beans, however, greater per cent of sprouting appears to follow greater rapidity of sprouting.

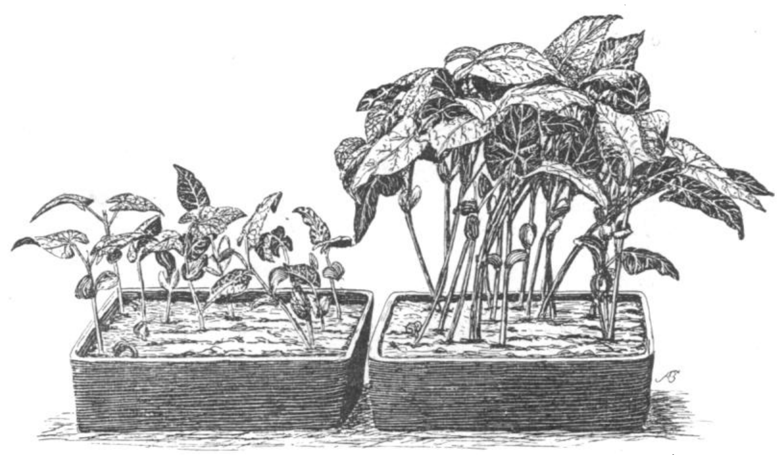
6. There is probably a tolerably well defined optimum temperature for each species of plant, in which best results from seed-tests can be obtained. This limit is not closely determined for most garden-seeds.

7. The quantity of water applied to seeds may determine both the rapidity and per cent of sprouting.

8. A comparatively small amount of water gives quickest and largest results.

9. Greater quantities of water than are required for best results lessen rapidity and per cent of sprouting either by causing the seeds to rot or by retarding germination, or by both.

10. The soaking of seeds in water before planting does not appear to hasten sprouting if the planting-time is reckoned from the time at which the seeds are put to soak; but, if planting-time is counted from the time of placing the seeds in soil, quicker sproutings are the result. This method of reckoning is incorrect, however.



White Seeds. FIG. 6. *Green-Colored Seeds.*

11. The soaking of seeds does not appear to influence the total amount of sprouting.

12. The results of soaking appear to vary in different species.

13. The character of soil in which the test is made may influence the results, both in rapidity and per cent of sprouting.

14. Light has great influence upon the sprouting of the seeds of some species.

15. When light has any influence, it retards or wholly prevents sprouting.

16. The effects of light upon sprouting are different in different species.

17. The weight of the seed is often a tolerably accurate measure of its viability, as determined both by rapidity and per cent of sprouting.

18. As a rule, heavy seeds germinate better than light ones of the same sample.

19. Seeds of different species may vary in sprouting in reference to weight.

20. The color of the seed in some cases is a tolerably accurate measure of rapidity and per cent of sprouting.

21. When there is any variation in viability in reference to color, it is usually found that the stronger sproutings occur in the darker-colored seeds.

22. The relative values of seeds of different colors vary with each species, or sometimes with each sample.

23. The latitude in which seeds are grown may determine their behavior in germination.

24. Northern-grown corn appears to germinate quicker than southern-grown corn. It is to be expected, from our knowledge of the variation of plants in reference to latitude, that seeds of most species will give similar results.

25. Variation in results of seed-tests may be due to the apparatus in which test is made.

26. Those apparatus in which the seeds are exposed to light are to be distrusted.

27. Those apparatus which afford no protection to the seeds other than a simple layer of cloth, paper, board, or similar cover, are usually unsafe, from the fact that they allow of too great extremes in amounts of moisture.

28. The so-called Geneva tester appears to give better results of sprouting than tests made in soil, probably from the fact that moisture and temperature are less variable than in the soil-tests.

29. In order to study germination to its completion, tests must be made in soil.

30. Tests made indoors are more reliable than those made in the field.

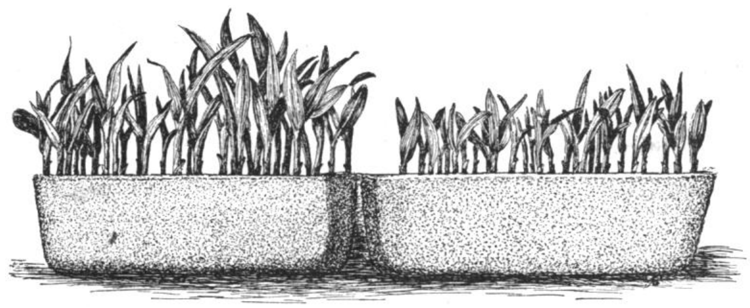
II. Results commonly vary between tests made under apparently identical conditions, even with selected seeds: therefore one test cannot be accepted as a true measure of any sample of seeds.

III. The results of actual ordinary planting in the field cannot be considered a true measure of the viability or value of any sample.

IV. Rapidity of sproutings, unless under identical conditions, is not a true measure of vitality or vigor of seeds.

V. There appears to be no pernicious adulteration of garden-seeds in this country, and, as a rule, there are no hurtful impurities.

In the ordinary farmer's garden, seed-testing is perhaps of little or no value; but to the market-gardener, who plants considerable areas to special crops, and to the seedsman, it is highly profitable. It is possible that in some cases the character of the crop can be prognosticated with some degree of certainty from behavior of plants in germination, wholly aside from percentages of sprouting. The studies of experts in this country and Germany indicate, that, when accurate information is desired as to the value of seeds, the seed-test should present at least the following data: name of variety, where grown, when grown, how kept, per cent by weight of foreign matter, per cent by weight of apparently good seeds, nature of foreign material, weight of seeds, manner of testing, number tested, average and extreme temperatures during trial, first germinations in hours, last germinations in hours, per cent by number germinated, per cent unsprouted but sound at end of trial, date of test, estimate of agricultural value.



Ithaca. FIG. 7. *Alabama.*

INHERITANCE OF INJURIES.

PROFESSOR A. WEISMANN of Freiburg, Germany, has made some experiments on mutilation. On Oct. 17, 1887, he had the tails removed from seven female and five male white mice. On Nov. 16 the first brood appeared. These and all subsequent broods were removed from the cage. Up to Dec. 17, 1888, 333 young were born, and in none of them was there any sign of the mutilation being inherited. In cage 2, fifteen young, of Dec. 2 1887, were placed, their tails having been removed. These, up to Dec. 17, 1888, produced 233 young, all with normal tails. In cage 3 fourteen young of the second generation, with tails removed, were placed; and up to Dec. 17, 1888, they produced 141 young, all quite normal. The experiment was carried, with a negative result, down through five generations of mutilated animals. The length of tail of new-born mice varies from 10.5 millimetres to 12 millimetres. In the series of experiments, 849 young were produced by mutilated progenitors, and in no case was a mouse produced with its tail less than 10.5 millimetres. The author points out, that, while it might be said that experiments through a far greater number of generations were needed, the so-called cases of inheritance of mutilation all imply that the mutilation is impressed on the immediately following generations. A mother breaks her finger, and her daughter has the joint of the corresponding finger imperfect. A cow has her horn torn off, and in due course gives birth to a one-horned calf. Moreover, there are many cases of mutilations which have been made for hundreds of years without result. For instance, Settegast shows that all the crows but the rook have bristly feathers on their beaks. Rooks, too, have these feathers while nestlings; but later on they lose them by perpetually pushing the beak into the ground in search of food. There are a great many cases which at first sight appear to prove the inheritance of injuries. As an example of how easy it is to be deceived, Weismann relates that a friend had a vertical scar (with comb-like striæ) on the left ear, the result of a sword-wound. On the left ear of this gentleman's daughter was a curiously similar marking. But it was ultimately noticed that on the right ear of the father was an appearance precisely similar to that on the left ear of the daughter. On closer examination of the father's left ear, there was seen under the scar a linear streak, from which the striæ ran, forming a comb-like structure. It was this, doubtless a

congenital variation, and not the accidental scar, that the daughter had inherited.

AMATEUR PHOTOGRAPHY IN THE SUMMER OF 1889.

THOSE who ventured to take photographs with the dry plates of eight years ago thought the art a simple one, and well suited to the needs of every one who was willing to go to any trouble in securing photographic record of sights and scenes in which he might be interested.

A year ago the Kodak was brought on the market. In this camera, which is known to all, and whose products are so favorably received wherever shown, in place of the glass negative of the

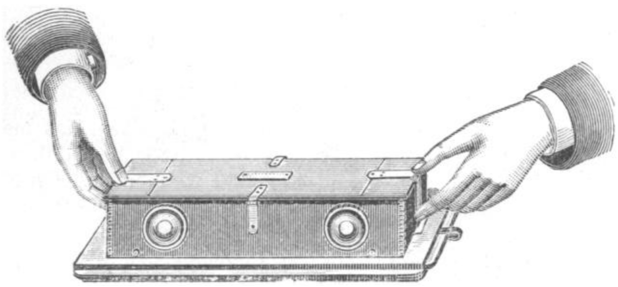


FIG. 1.

past was substituted a strip of sensitized paper stretched between two reels.

This was but a partial solution of the problem, for the paper is of necessity opaque, and to secure the best results it was necessary to strip the delicate film from the paper and attach it to glass or some other transparent support. This was a tedious process. A recent discovery and invention by Mr. George Eastman of the well-known firm in Rochester, obviate every difficulty. He has succeeded in producing a strong and perfectly transparent support, of great flexibility and extreme thinness, which can be wound upon rollers, to be exposed, developed, and printed like ordinary glass negatives. The transparent support is a modification of celluloid, specially prepared by a process invented by Mr. Eastman. The celluloid product is but four one-thousandths of an inch in thickness, and the gelatine film upon it is one two-thousandth of an inch

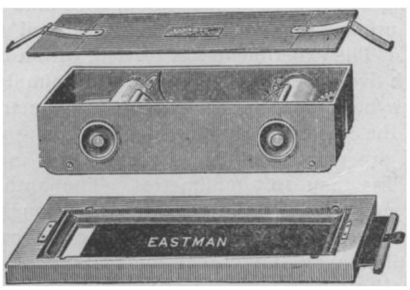


FIG. 2.

in thickness. It will thus be seen that a great magazine of photographic material can be carried in a very small space, and with no inconvenience on account of weight. Every operator can develop and print his own negatives and refill his magazine, with the exercise of only ordinary skill.

Mr. Eastman has removed the greatest difficulty in the way of rapid and satisfactory outdoor work, while adding facility in indoor photography, especially on large work. The handling of large plates is always difficult, and attended with serious risks. The flexible, transparent support makes the handling easy, and the results secure. The new support has been thoroughly tested. It withstands sun-heat necessary in printing, and is unaffected by the chemicals employed in development and other photographic processes.

The accompanying illustrations show the film-holder for the Kodak camera. Fig. 1 shows the holder closed; and Fig. 2, the same open, with a view of the two reels.

HEALTH MATTERS.

The Alleged Spontaneous Combustion of the Human Body.

WHEN "Bleak House" appeared, in 1853, novel-readers were treated to a new sensation in the way of a death-scene, when Krook was taken off the stage by spontaneous combustion, "of all the deaths that can be died." The public shuddered, and medical readers smiled. The subject was then to most physicians, as it is now, well inside the border of medical mythology.

Within the past year or two, several cases have been put on record, which, with the list previously accumulated, serve to establish pretty clearly, in the opinion of *The Boston Medical and Surgical Journal*, "the fact of an occasional abnormally increased combustibility of the human body, which, it should be observed, does not necessarily imply ignitability, or true spontaneous combustion."

For instance: Dr. Booth's case, which is reported, with a photograph of the nearly consumed remains, in the *British Medical Journal* (vol. i. 1888, p. 841), is of a pensioner, aged sixty-five, of very intemperate habits, who climbed into a hay-loft while drunk, at nine P.M. Neighbors saw by a skylight a light struck, which after a while was put out. At eight the next morning, the body, with all its soft parts consumed, was seen lying over a hole in the floor which had nearly burned through, but had one or two joists that kept the body from falling through. The chance of the application of fire to the man's clothes is here distinctly stated; and the combustion, remarkable as it was, is not shown to have been spontaneous.

Again, Middlekamp, in the *St. Louis Medical and Surgical Journal*, October, 1885, reported a similar case of nearly complete combustion, where the victim, a man of sixty-six and a drunkard of twenty years' standing, fired a gun at his own breast with a ramrod. Here the heat was so intense as to melt the ramrod and a metal buckle. The body was consumed entirely, except the lower part of the legs, the head, and the arms.

In the *Therapeutic Gazette* of the current year, two more such instances are reported. One of these, Dr. Clendenin's case, was an old Irish woman, addicted to the excessive use of whiskey, of which she had drunk a quart the day she died. She had always been the last of the household to go to bed, and so always extinguished the tallow candle (their sole means of illumination). There was also a fire in the kitchen stove. The inner walls of the house were covered with greasy soot, and the two old men who were the only other occupants were both asphyxiated. A hole was found burned through the kitchen floor about two and one-half by three feet square. Upon examining the opening in the floor, a mass of cinders was discovered on the ground beneath. Upon removing them, the skull, the cervical, and half the dorsal veretebræ were found reduced very nearly to a cinder, also about six inches of the right femur, together with part of the ilium in about the same state as the vertebræ. The feet were found in the shoes: the left foot was reduced to a cinder, the shoe being partially calcined; the other foot and shoe were reduced to a complete cinder. On removing, the entire remains of a woman, who a few hours previous had weighed one hundred and sixty pounds, were placed in a box that would hold less than one bushel. The entire remains weighed twelve pounds. The pine joint against which the remaining cinders lay were slightly charred, but not burning when found.

To burn the human body, under ordinary circumstances, as the editor of the journal states, is not an easy thing. The great heat secured in crematories, and the length of time even then requisite to incinerate the body, illustrate this fact. It has been shown that the body is three-quarters water, and a great deal of combustible material is a necessary adjunct to the successful reduction of so non-inflammable a substance. What, then, is it that occasionally imparts to it so abnormal a susceptibility to flame? Here theories are at fault. We may safely say that it is not, as has been claimed by some, alcohol deposited in the tissues: for Liebig found that flesh saturated in that liquid would burn only until the alcohol was consumed. The hydrogen theory is also fanciful; and the best explanation, namely, an abundant deposit of fat in the cells of the body in such cases, fails to account for the fact that not

all fat people are subject to this fate, but that it is only the fat, elderly alcoholic subjects that have been shown to manifest abnormal combustibility. Possibly the alcohol in such cases has the double effect of laying up fat and stupefying the subject, so that he is unable to save himself when he does take fire.

One of the best recent monographs on this subject is that of Dr. F. Ogsten (*British Foreign Medico-Chirurgical Review*, vol. xlv. p. 179), which details a case of his own, — again, be it observed, one where the spontaneous element was wanting, or was not proved. A woman, fat, imtemperate, was in front of smouldering ashes in a grate, and was almost wholly consumed, with little burning of the surrounding objects, and with nothing specially inflammable about her. Ogsten seems to have had some doubt on this subject, seven years later, in referring to the same case (*Medical Times and Gazette*, vol. i. 1877, p. 27), when he says the question is still *sub judice;* but he admits that one cannot explain the facts in this case without assuming that the body was in a condition unusually favorable for and predisposed to the feeding at its own fire.

In the monograph referred to, Ogsten collected the opinions of thirty-five authors who treated of this subject, and he thus classified them: five were quite sceptical on the whole subject, three believed in increased combustibility only, and twenty-seven believed in spontaneous ignitability as well.

The opinion of the editor of the *Medical and Surgical Journal* is, therefore, that the necessarily isolated condition of all persons who perish in this way, and the commonness of fires and lights or of the means of producing them in all places, would make it extremely difficult to establish the fact of spontaneous ignitability, even did it exist. Certainly such proof has not yet been given us. The other point, that of increased combustibility, seems to have received considerable confirmation.

Elimination of Poisons.

In an exceedingly interesting and valuable Croonian lecture on chemical structure and physiological action, recently delivered before the Royal College of Physicians of London by Dr. T. Lauder Brunton, there is a passage in which he discusses the treatment of diseases depending upon infection of the blood or tissues by microbes. In this he calls attention to the difficulty of destroying or weakening microbes, once fairly occupying the animal economy, and the greater probability of success by promoting rapid elimination of the poisonous products of micro-organisms, as well as of the micro-organisms themselves.

One of the most important methods of such elimination is free purgation; another is active diuresis; and a third, not alluded to here by Dr. Brunton, is free sweating.

One of the best diuretics, Dr. Brunton says, is a free supply of water; and Ringer has pointed out the possibility of lessening the effect of poisons by washing them, as it were, rapidly out of the system. This plan has recently been followed by Sanquirico with very striking results. In his experiments he injected quantities of a weak saline solution directly into the veins immediately after the poison had been administered, or just when the symptoms of poisoning began to appear. By treatment in this way he found that three times the ordinary lethal dose of strychnine had to be administered before death occurred. The poisonous action of chloral, alcohol, urethan, pareldehyde, caffeine, and aconitine was also diminished, but not very much; while that of morphine and nicotine was unaffected. In all cases the beneficial effect of the treatment was most marked when the diuresis was greatest. No doubt, the effect of fluids is likely to be greater when they are introduced directly into the veins than when they are introduced indirectly through the alimentary canal; but the effect in both cases will be the same in kind, though different in degree.

The principles laid down in these statements, *The Medical and Surgical Reporter* remarks, are probably those which lie at the base of the empirical practice of hundreds and even thousands of years; and they furnish an interesting demonstration of the way in which reason often, by slow steps, demonstrates the wisdom of practices long since adopted under the spur of instinct or in imitation of nature.

HYGIENIC POLICE REGULATIONS IN BERLIN. — The Berlin correspondent of the *Medical Age* (June 10, 1889) says that the city of Berlin in many respects is exemplary in its hygienic care and dispositions, especially in its regulations concerning buildings, streets, victuals, and, last but not least, the patent-medicine man. No house is allowed to be built until its plans have passed not only ordinary police inspection, but also a special "hygienic committee," which rejects, of course, every thing which is not in accordance with the principles of hygiene. The streets of Berlin are the objects of admiration of all foreigners, who speedily are awakened to the shameful and outrageous treatment to which they have been subjected for years. Berlin is paved almost exclusively with asphaltum and Belgian blocks, and the streets are always bright and clean-looking, regardless of weather. The inspection of victuals is so rigorous that poisoning from trichinæ, or from decomposed meat, fish, or other eatables, is an exceedingly rare occurrence. Quite recently, 24,000 pounds of fish, just from Denmark, were confiscated and destroyed. No milk-wagon is allowed to enter the city until the specific gravity of the milk has been ascertained. Regarding patent medicines, the Berlin police have resorted to very simple means to protect the public; viz., by the absolute interdiction of patent-medicine advertisements in newspapers and other public prints. It will be seen by the foregoing that citizens of Berlin are not permitted to care for themselves, as is the hazardous privilege of Americans, but the government assumes the responsibility of all hygienic and sanitary precautions.

SIR SPENCER WELLS ON CREMATION. — The London *Lancet* (June 8, 1889) says that Sir Spencer Wells deserves credit for the pains he takes to disseminate a knowledge of the arguments for cremation in Great Britain, and of the success which this method of disposing of the dead meets with. It is impossible to deny the strength of the arguments in favor of cremation as a most effective and prompt way of reducing the body to its mineral elements, which process, the *Lancet* says, can be carried out now at Woking at the small cost of ten shillings per body. Sir Spencer Wells argues, that, however light the covering of the dead body, its burial in earth is objectionable, for the reason that infective germs are in this way preserved and carried about by water or air, to operate injuriously when favorable meteorological or social states occur. The rapid growth of population, and especially of urban populations, due to a greater prevalence of peace and a more satisfactory sanitary system, invests this question with ever-increasing importance. The religious objections have been completely answered by men like Lord Shaftesbury and Bishop Fraser. There is evidence that the number of cremations is increasing in Italy and England, as in the week preceding Sir Spencer Wells's speech there had been three cremations at Woking; while in Italy, in the three years 1886, 1887, and 1888, there were 119, 155, and 202.

NOTES AND NEWS.

THE opening season of the tenth annual convention of the National Photographers' Association was held at the Mechanics Building, Boston, on Aug. 6. Mr. J. F. Ryder of Cleveland gave an address of welcome. The next meeting will be held at Detroit. The exhibition of apparatus and pictures was open till to-day. The Eastman Dry Plate and Film Co. of Rochester showed a notable collection of large pictures. Cramer of St. Louis displayed some of the results from his orthochromatic dry plates, which give the true value of the colors in originals.

— London *Industries* reports that C. A. Paillard has recently drawn attention to the valuable properties of some of the alloys of palladium, and advocates their use in the manufacture of non-magnetizable watches. The composition of four alloys has been ascertained, and the author has examined their respective properties. An alloy consisting of palladium 60.75, copper 15.25, and iron 1.5 per cent, is readily formed by mixing half the palladium with the copper and iron, and fusing the mixture with borax and powdered charcoal. The remaining palladium is then added, and the alloy fused and poured into moulds.

— A sister of the late Maria Mitchell will prepare for the press the "Life and Letters" of the distinguished teacher. Her correspondence is said to be very rich in letters from Herschel, Humboldt, and others.

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CONTENTS:

THE WEEK'S PROGRESS in the preparation for the world's fair in this city in 1892 shows mainly, as is to be expected, in the recommendation, by various commercial and industrial bodies, of persons whom they wish to represent them on the committee of one hundred which the mayor proposes to appoint. So far, no action has been taken by scientific men toward giving suggestions as to the features of the exposition in which they would care to take part; and, while naturally scientific interests are not as keen as those which give the main impulse to the undertaking, it is desirable that the scientific men of the country should be heard from; and we cordially invite a free discussion in the columns of *Science* of the ways by which the interests of American scientific men may be served best by the exhibition. An accompaniment of every exhibition is a series of scientific congresses. To be sure, such congresses to the number of nearly a hundred will have been held in Paris before the close of the summer; but all questions will not be settled by them, and by the summer of 1892 the scientific men of the world will be ready for further debate.

At the present stage of affairs the discussion of the site is going on vigorously, Governor's Island finding a good many advocates. When there was talk of a world's fair eleven years ago, the witty editor of the then flourishing *Appletons' Journal*, Mr. O. B. Bunce, urged Governor's Island as a site in the following terms: "This island is one of the general government military centres, but we may assume that Congress or the executive, wherever the power lies, would promptly surrender it for the purpose proposed. The situation is superb. It is nearly at the junction of the Hudson and East Rivers, less than a mile from the Battery, and is equidistant from Brooklyn and New York. It lies directly upon the channel which leads to the sea; is fanned by breezes from the ocean and rivers; is healthful, salubrious, and every way charming. Ships from abroad could land their cargoes for the exhibition at the doors of the structures without a foot of land-carriage. Boats down the Hudson, boats from the East through the Sound, steamers from Southern ports, and lighters from the great railroad-depots at Jersey City, could do the same. A ferry would have to be established at the Battery, where are the termini of the elevated railways, which reach through the city to its uppermost limits, thus giving easy and convenient access from every point; while with ferry-boats in addition at points along each river, at Brooklyn, and at Jersey City, the great crowd of visitors could be gathered and dispersed with so little friction and so much comfort as to make this world's fair memorable compared with all others. Those who recollect the fatigue and torment of getting to and from the Philadelphia exhibition must welcome this feature of the prospect with delight; and in all of the exhibitions, so far, the journeyings to and fro have been fatiguing and tedious to a degree almost to overweigh the pleasure derived from the wonders on display. Governor's Island is between sixty and seventy acres in extent, and, as the area of the Philadelphia buildings is over fifty acres, the place may at first thought seem too small. This difficulty can be met by having galleries in the buildings, as was the case in the first Crystal Palace, and by erecting some of the structures over the beach supported by piles. Superb façades could be constructed at the water's edge, facing the harbor and the city, presenting a grand picture to the approaching visitors."

In a recent communication to the *Evening Post*, Mr. Bunce states that the island is a mile and a quarter in circumference, its shape being elliptical. A building encircling the island at the water's edge (which might rest partly on sea-walls) would be of greater length than the united length of the buildings at the Centennial Exhibition, the dimensions of which were as follows: main building, 1,876 feet; machinery hall, 1,402 feet; art gallery, 365 feet; horticultural hall, 383 feet; agricultural hall, 820 feet; making a total of 4,846 feet, with an average width of about 350 feet. A structure encircling the island 400 feet in width would exceed the capacity of the Philadelphia structures fully fifty per cent, and leave the greater part of the island free for the erection of special buildings by the States or otherwise. Whether the form of building here suggested would be adopted is not yet to be decided, but the figures show that there is considerable room on the island, and engineers might be depended on for a few annexed strips out over the water if need should be. The exhibition is to be held, unless all signs fail; it is to be held in New York as the great commercial centre, made so by its being the most accessible city in the United States; and we now urge on scientific men to take such action as will give due prominence to what they are doing for the world's advancement.

THE WHAT AND WHY OF AGRICULTURAL EXPERIMENT STATIONS.

PROFESSOR W. O. ATWATER, director of the Office of Experiment Stations, of the United States Department of Agriculture, has issued Farmers' Bulletin No. 1 of that office, containing a brief statement of the history, work, and aims of the agricultural experiment stations.

This bulletin is intended as the first of a series the object of which is to give information about the experiment stations and their work by collating results bearing upon special topics, and putting them into brief, clear, practical form for farmers and others

to read. A series of experiment-station bulletins, of which the first has been published, is intended to furnish accounts of current operations of the stations, and kindred information for station workers and others interested in agricultural science.

What the Stations are for.

"Farming is a perpetual trying of experiments with soils, manures, and crops; with cattle and cattle-food; with milk, butter, and cheese; with ploughs, harrows, and harvesters; with an almost endless list of things. The most successful farmers — those who get the most out of their land, their cattle, their crops, their fertilizers, their implements, and their labor — are those who experiment themselves most industriously, most skilfully, and most intelligently, and who take the fullest advantage of the experiments of others. The best agriculture is that which, in old countries, on worn and intractable soils, has learned by long-continued and varied experiment to make the gain of farming sure."

Once the farmer made the rude tools he needed for the primitive practice of his art. Now he employs implements and machinery which can be made only with large capital and the highest mechanical skill, and by men who make this manufacturing a business. So the experiments which he can make do not meet his needs to-day. Research, the finding-out of nature's secrets, the discovery of the laws which underlie the right practice of agriculture, is costly. The more useful it is to be, the greater must be the outlay of money, labor, and scientific skill. Here, if anywhere, wise economy calls for the best.

Within recent times farmers, and men of science interested in farming, have seen the advantage of using the resources of science to improve the practice of agriculture, and have established agricultural experiment stations.

The object of these stations is to experiment and to teach, "to make a regular business of discovery for the use of farming," "to promote agriculture by scientific investigation and experiment," and to diffuse as well as increase the knowledge which improves farm-practice and elevates farm-life.

Established for the benefit of agriculture, and hence of the community at large, the most of them connected with educational institutions where experience shows their work is most successfully done, these stations seek answers to the questions which agricultural practice is asking as to the tillage of the soil; the nature and action of manures; the culture of crops; the food and nutrition of domestic animals and of man; the production of milk, butter, and cheese; the diseases of plants and animals; and, in general, whatever the agriculturist needs to know and experimental science can discover.

But farmers have asked and have received from the stations more than the help to improve their crops and their cattle and to make more money. They have felt the need of something higher and better for themselves, their wives, their children, their homes, and their profession. In the isolation and the day-by-day struggle of farm-life, the opportunity for intellectual culture is all too small. Modern science reveals operations of nature in their truth and beauty, and lifts us, by their contemplation, out of ourselves to higher things. It finds as much that is wonderful in the growth of a blade of grass as in the motions of the planets, as much of inspiration in the process by which a clod of earth gives up its fertility as in the forces that keep the stars in their places in the universe. It shows us how the things we have to deal with in our homeliest toil connect us, if we but understand the linking, to what is most elevating in man's thought and hope. It helps supply that food for the mind without which we starve in drudgery, but by the strength of which we rise to a higher plane of life. It is for the acquiring and diffusing of such knowledge, which is explained in books, popularized in lectures, and disseminated in the columns of the best papers; which interests the home circle, and supplies themes for farmers' institutes and conventions; which helps farmers to improve their business and increase their incomes, while it elevates farming as a profession, and, what is by no means the least of its benefits, shows the boys that it is a profession in which brains can be used with profit, — it is for this, as well as for their help to farm practice, that experiment stations are established, and their workers are laboring with so much enthusiasm.

What the Stations do.

The stations make experiments in the laboratory, the greenhouse, the garden, the orchard, the field, the stable, and the dairy. It is doubtless safe to say that there are few subjects which the farmer has to deal with in the tillage of the soil, the saving and use of manures, the cultivation of his crops, the care of his stock, the management of his dairy, and the preservation of his crops or stock from insect pests and from diseases, that are not being studied, directly or indirectly, by one or more agricultural experiment stations.

The space here allows only a single illustration of the methods and spirit of experiment-station work. Suppose the question to be one of feeding. What are the effects of different kinds of fodder, as hay, corn-meal, or bran, fed to cows, upon the quantity or quality of the milk? Or what feed shall we use to make better pork at less cost? Or what are the most economical rations for fattening steers or working horses? To get answers to these questions, the stations make actual tests by feeding the animals and noting the results. These tests differ from ordinary farm experiments in that they are more elaborate and accurate; in other words, more scientific.

Successful feeding is not merely a matter of so much hay, or corn, or turnips, but of the nutritive ingredients which they contain, and which the animal digests, and uses to make blood, bone, muscle, fat, or milk, or uses as fuel to keep it warm and give it strength for work. The chemist of the station, with the apparatus of his laboratory, analyzes the material fed; that is to say, he separates the food into its constituent parts, and finds just how much of each nutritive substance the animal consumes. Sometimes the excrement, the undigested portion, is also weighed and analyzed; so that, by comparing this with the food, he learns how much of the whole food and of each ingredient the animal actually digests. In experiments with milch cows, the milk is likewise weighed and analyzed, and sometimes the cream is churned to see how much butter it will make. In some experiments even the air the animals inhale and exhale is measured and analyzed with the aid of very elaborate apparatus. When the feeding-trial is done, the animal is sometimes slaughtered, and the different portions likewise weighed and analyzed. By such means the effects of different kinds of fodder, and methods of feeding and treatment, are learned. A single experiment often requires the labor of several men for weeks or months. The same experiment has to be repeated again and again with different animals, under different conditions. So much does it cost to get reliable answers to the seemingly simple questions which farmers ask.

A recent editorial in one of our leading live-stock journals says that "by the feeding-trials already conducted, especially with young animals, it has been demonstrated that different feeds modify the relative proportion of the different organs of the body; that the blood can be increased or diminished, the liver made larger or smaller, the muscular system increased or decreased in proportion to the rest of the body . . . [even the bones can be made weaker or stronger]. These marked differences in results are not produced either by over or under feeding, but by the difference in the chemical constituents of the ration. Here is a side of live-stock management that is practically new to us, and its development must be of the highest importance."

It is an old saying that "the best part of the breed goes in at the mouth;" but it has been reserved for the experiment stations to show how and why this is so, to give the scientific explanation of the maxim, and to put stock-feeding upon a more rational, that is to say, a more profitable, basis. And they are studying in like manner, and with like results, the other important problems upon which the future progress of our agriculture depends.

Origin and Development of the Stations.

Nearly forty years ago a company of farmers joined themselves together in the little German village of Moeckern, near the city and under the influence of the University of Leipzig, called a chemist to their aid, and, with later help from government, organized the first agricultural experiment station. Liebig in Germany, Boussingault in France, Lawes and Gilbert in England, and other great pioneers, had been blazing the path of progress for years before.

A great deal of research bearing upon agriculture had been and is still being carried on in the schools and universities; but the action of these Saxon agriculturists in 1851 marks the beginning of the experiment station proper, — the organization of scientific research with the aid of government "as a necessary and permanent branch of agricultural business."

The seed thus sown has brought forth many fold. In 1856 there were five, in 1861 fifteen, in 1866 thirty, and to-day there are more than one hundred, experiment stations and kindred institutions in the different countries of Europe. In each of these, from one to ten or more investigators are engaged in the discovery of the laws that underlie the practice of farming, and in finding how they are best applied.

So rapid and so sure has been the progress of this enterprise in both hemispheres, that private persons, educators, societies, and governments have learned the usefulness, and indeed the necessity, of these institutions, not for the farmer alone, but for all who are dependent upon the products of the soil. The movement is extending to Asia and to South America: everywhere, indeed, its importance is coming to be felt.

The first agricultural experiment station in America was established at Middletown, Conn., in the chemical laboratory of Wesleyan University, in 1875. The example was speedily followed elsewhere. In 1880 four were in operation, and in 1887 there were some seventeen of these institutions in fourteen States. In that year Congress made the enterprise national by an appropriation of $15,000 per annum to each of the States and Territories which have established agricultural colleges or agricultural departments of colleges. This has led to the establishment of new stations, or the increased development of stations previously established under State authority; so that there are to-day forty-six, or, counting branch stations, fifty-seven, agricultural experiment stations in the United States. Every State has at least one station, several have two, and one has three. Before provision had been made by the last Congress for the admission of the new States, Dakota had established one within her boundaries, and several other Territories are preparing to do likewise.

These forty-six stations now employ over three hundred and seventy trained men in the prosecution of experimental inquiry. The appropriation by the United States Government for the fiscal year just closing, for them and for the office of experiment stations in this department, is $595,000; for the coming year it is $600,000. The several States appropriate about $125,000 in addition, making the sum total of about $720,000 given from public funds the present year for the support of agricultural experiment stations in the United States. This may seem like a large sum to expend annually for agricultural experiments, but it is less than 10 cents for each of the 7,500,000 farm-workers of the country, less than 2½ cents for each of the 30,000,000 of our population directly dependent upon agriculture for their support, and less than 1¼ cents for each of the 60,000,000 of our people who consume the products of our farms. The farming-lands, farm-implements, and live-stock of the country are estimated to be worth $12,000,000,000. The experiment stations cost us, therefore, about $6.25 a year for every million dollars invested in agriculture; or, reckoning the annual value of the products of our farms at $2,200,000,000, we are now spending about 33⅓ cents for every thousand dollars' worth of products in an attempt to increase the value of those products in future years.

The European Stations.

Of the experiment stations and other like institutions for agricultural research in Europe, sixty-two are in Germany. These latter employ two hundred and seventeen scientific specialists. According to the best accessible accounts, twenty-seven German stations exercise control of commercial fertilizers, twenty-nine of feeding-stuffs, and thirty of seeds by examination of wares in the interest of the purchaser; this, however, in most cases, being only part of the work done. Some stations follow a number of lines of inquiry, others confine themselves to one or two. In general, those have been most successful which have studied the smallest number of questions in proportion to their resources; or, to put it in another way, experience has shown the advantage of specializing. Fifteen are devoted mainly to investigations in vegetable physiology, including nutrition of plants; seven to animal physiology, including feeding-experiments; three to dairy industry; four to sugar-beet and three to fruit and vine culture. Nine have buildings for vegetation experiments, four have special structures for feeding-experiments with animals, and two have experimental gardens. While they conduct more or less field-experiments (the first station was started on a farm), few own experimental farms; and those few make but little use of them, for the simple reason that experience has shown, that, generally speaking, the things which most help farmers, outside of what they can study on their own farms, the stations can best find out in the laboratory, the greenhouse, and the experimental stable. They have learned the costly but most valuable lesson that the kind of experimenting which seems on the surface the most practical is apt to prove the least useful, and that it requires abstract and profound research to discover the things which the plain, ordinary farmer needs to know.

The European stations have become as firmly established as schools, and for the same reason; namely, that their value is demonstrated beyond question. A single illustration of their usefulness will suffice here. "The consummate product of applied farm-science is the 'Farmers' Almanac,' which tens of thousands of German farmers carry in their pockets. It contains a calendar; tables of movable feasts; blanks for daily memoranda, cash accounts, and so on, such as we have in our diaries. Then follow blanks for names of workmen, their work and wages; forms for registering cows and their daily or weekly yield of milk, and for other stock; other forms for keeping account with each field on the farm, — its size, crop, manure, seed, and produce; and so on. Then comes a series of tables and statements which compress in brief space an amount of pertinent information that is almost marvellous.

"One table gives the amount of seed by weight or measure needed per Prussian acre (morgen) or hectare, broadcast or in drills or hills, for each of ninety-five different kinds of crops. Another gives what they call in Germany fair yields (they would be large yields here), with duration of germinating power of the seed, period of growth of the plants, and what corresponds in German weights and measures to weight per bushel or bulk per 100 pounds of the different kinds of produce. Further on are tables of mixtures of grass-seeds for different soils and purposes, number of plants per acre, valuation of seeds, and so on.

"But the most remarkable tables are those of the chemical composition of plants, fertilizers, feeding-stuffs, fodder-rations, and human food, and even of the whole bodies of animals.

"If the farmer wishes to find how much plant-food he has removed from his field in a hay-crop of 5 tons, he turns to a 'Table for Calculating the Exhaustion and Enrichment of the Soil,' and finds that the 5 tons of hay would contain about 155 pounds of nitrogen, 132 pounds of potash, 8½ pounds of lime, 41 pounds of phosphoric acid, and so on. The composition of nearly two hundred kinds of grasses, grains, straws, root-crops, etc., are given in this table. If he now wishes to calculate how much plant-food he gives back to his field with a given amount of manure, he turns to another part of the table, and finds the average composition of one hundred and twenty-six kinds of manures and fertilizing materials. There are, too, clear figures and explanations to help him calculate how the analysis of a fertilizer compares with standard articles of this sort, and what it is worth. From other pages he learns how to calculate how much material ought to be produced by given kinds of animals from given food, and so on.

"Not a bit less valuable are the tables of the composition of feeding-stuffs and fodder-rations. The farmer sees at a glance how many pounds of the valuable food-ingredients — proteine, carbohydrates, and fats — there are in hay, straw, corn-stalks, bran, cotton-seed meal, and two hundred and fifty other materials which German farmers feed to their stock. Close by is a table of feeding standards, which tells how much of each of these ingredients will make a fair daily ration per 1,000 pounds, live weight, of oxen at rest in the stall, oxen at work, milch cows, young cattle, and so on. By comparing the composition of these standards with that of the feeding-stuffs in the barn or store, rations can be calculated which will bring the largest amount of work or meat or milk at the least cost. Of course, these rules are not to be followed

blindly: experience and good judgment combined with the rules make the book useful to the farmer."

The information contained in the almanac does not all come from the agricultural experiment stations; but a large amount of it, and that which is really most useful, does come from them, and would not be available without them. Nor is this all. The disposition and ability to use all this are as important as the information itself. This, too, is greatly aided by the scientific and educational work of the stations.

We want the same things in this country. Much of the fruit of foreign research and experience can be made available for our own use; but it needs working over to fit it to our needs, and we must have independent investigation of our own.

What the American Stations are doing.

Although the first of the American stations was established less than fourteen years ago (Oct. 1, 1875), and the majority of them have been in operation scarcely a year, they have already done a large amount of work scientifically creditable, and of the largest practical value. Future publications of this office will describe what the stations are doing, and explain the practical results. Only a few general statements and illustrations can be given here.

Our stations are conducting a large amount of scientific research in the laboratory and the greenhouse, and an equally large amount of practical experimenting in the field, the orchard, the stable, and the dairy. Some stations make a specialty of experiments with home-made and commercial fertilizers; others are endeavoring to show what can be done to restore the fertility to worn-out lands; others deal largely with the culture of fruit in orchards and vineyards; others are engaged on work relating to the composition of fodders and the methods of storing them; others are experimenting on the feeding of animals, and still others on diseases of animals and plants and their cure. Irrigation receives a good deal of attention in Colorado, sugar-making in Louisiana, wine-making in California. At least one station is doing something in poultry-raising, and another in the keeping of bees. Most of the stations give attention to several lines of work.

It is only the older stations from which we have a right to expect the most satisfactory results. The oldest is the Connecticut State Station. In this State the farmers are especially interested in manures and fertilizers, and in cattle feeding and dairying. This station has naturally devoted a large share of its attention to commercial fertilizers and feeding-stuffs. The result has been that inferior materials have been driven from the markets of the State; and not only that, but the farmers have been taught much concerning the relative values of the materials they buy or produce for feeding their crops and their stock, and how to utilize them most advantageously. Besides this and a great deal of other practical work, the station has done much to benefit other stations and the agriculture of the whole country by scientific researches relating to the methods of agricultural investigations.

When the station began its work in 1875, a number of brands of fertilizers then being sold in the State were analyzed, and their composition compared with the selling price. It appeared, that, at the rate farmers were paying, the nitrogen cost from 10¾ cents to $1.67, and the soluble phosphoric acid from 10¾ to 25½ cents, per pound. The report of the station for 1888 shows the nitrogen in the fertilizers sold in the State in that year to cost from 12 cents to 18 cents, and the soluble phosphoric acid from 8 cents to 8½ cents. There were no fraudulent articles in the market. Connecticut farmers pay over $200,000 yearly for the phosphoric acid of commercial fertilizers. In this item alone the station saves more than its cost.

Before the establishment of the stations, very few farmers in New England knew how to judge of the value of a guano or phosphate from its composition. Chemical terms were Greek to them. Of the demands of plants and the deficiencies of soils, they had very little idea. Two or three years ago an advertisement of a firm of fertilizer manufacturers was circulated in Connecticut and in other States thereabouts. There was not a word in it about the remarkable increase of crops which the fertilizers would bring; there was not a single recommendation from a farmer who had put them to practical test, and learned their wonderful value; but there were statements of percentages of nitrogen, of phosphoric acid, soluble, reverted, insoluble, and of potash as sulphate and chloride, which the fertilizers had been guaranteed by the manufacturers to contain; and alongside these were given the percentages which had been found in the articles as the farmers had bought them and the stations in their behalf had analyzed them. This is a firm of shrewd business-men, who manufacture and sell fertilizers to make money. They had found that farmers had learned something of chemistry, and were buying their fertilizers on a scientific basis, and that to get the most and the best trade it would pay them to advertise and sell on that basis.

At a meeting of the Connecticut State Board of Agriculture, in December, 1888, one day was devoted to the experiment stations, of which there are now two in the State. It has been the policy of the stations to institute experiments among farmers on their own farms, both for practical and for educational purposes. Some of the experimenters were present, and gave accounts of their work regarding the use of fertilizers, and what they had learned from it. They talked of nitrogen, phosphoric acid, and potash; of agricultural and commercial values of fertilizing materials; of the feeding capacities of different plants; of the differences in soils; of the adaptation of fertilizers to soil and crop; of the relative merits of commercial fertilizers and farm manures as shown by the cost, composition, and effect upon quantity and quality of crop produced; of the different methods of applying manures; and of other kindred topics. Their statements were scientifically accurate, and the practical value was so plain as to be appreciated by every one who heard them. One of the station directors, a college professor, remarked that he sat through the whole discussion ready to rise and make explanations if they were called for, but found no occasion to do so, and felt as though his occupation was gone.

The men who thus united science with practice, who showed their fellow-farmers how much of pecuniary profit as well as mental satisfaction there was in all this work, earn their living on their own farms by the labor of their own hands. They had enjoyed no better education than their neighbors, but they had taken advantage of the help of the experiment station. Such men are lighthouses. The value of their influence cannot be estimated. Where such work is done, farming will flourish. The tendency of such things is to make agriculture a profitable, elevating, and attractive profession.

The experience in other States is the same as in Connecticut. A farmer in New Jersey, who has conducted some of these experiments under the direction of the station in that State, says that the simple fact that he has learned from them "that his soil lacks potash," which is cheaply supplied by German potash salts, has already been worth $500 to him. Another farmer in the same State told the writer that the information he had got from these experiments had been worth more than $2,000 to him in a single year. And it must be borne in mind that the subject of "fertilizers" is only one of the many which the stations are working upon.

The first decade of the life of the North Carolina Station, which was begun in 1877, has been devoted, for the most part, to problems relating to the control of the trade in commercial fertilizers, to the investigation of natural fertilizers (marls, phosphates, etc.) and the best methods for their use, and to the education of the farmers about farm manures and the best ways of saving, composting, mixing, and using them. Among the valuable results due directly or indirectly to this work are an increase of 14 per cent in the quality of the commercial fertilizers sold in the State, and a decrease in the number of acres devoted to cotton; the establishment of fertilizer factories and cotton-seed-oil mills in the State, and the making of thousands of home-made composts by farmers in every section of the State.

The New Jersey State Station was established March 18, 1880. Its work has been both scientific and practical. The analyzing of commercial fertilizers, fodders, and feeds offered in the markets of the State has been largely and regularly carried on, with important results in securing purity of product and honesty of dealing, and in teaching the farmers of the State the real commercial and agricultural value of these fertilizers. Field-experiments have been made with a large variety of barnyard and commercial fertilizers on different crops in most of the counties of the State.

The diseases of plants, vines, and trees have been studied, and remedies sought, and the station has tried to introduce new crops in sections of the State hitherto comparatively barren. The sorghum experiments for this purpose have attracted attention throughout the whole country. It is safe to say, that, in the scientific and practical value of its work, this station is equalled by extremely few of the European stations.

The station had been steadily growing in the favor of the farmers and general public of the State, and is now regarded as an educating agency of the first importance. Farmers depend upon its work, manufacturers of fertilizers are made careful, dealers in seeds and implements seek its approval. The progress of agriculture in New Jersey is marked by larger staple crops; higher enrichment of the soil; extended cultivation of market-garden products, peaches, and small-fruit; and a great increase in dairying. Even from year to year the progress is plainly marked. That the station contributes much to this progress, there is no room for doubt.

Louisiana has three stations, the first of which was established in October, 1885, by an association of sugar-planters; and the last, in April, 1888. These stations have already accomplished much useful work, including investigations of the manurial requirements of various staple crops of the State; analyses and classification of the soils of the State; analyses of all the commercial fertilizers sold in the State; experiments with forty-two varieties of cotton to determine the relative yield of lint, length of staple, and strength of fibre; and the introduction, with the aid of the United States commissioner of agriculture, of more than seventy varieties of sugar-cane, forty-eight of which are now cultivated in the State. Each station is the headquarters for a large agricultural association, which holds monthly meetings on the station grounds. At the North Louisiana Station, at Calhoun, the farmers have raised by subscription the means to build a hall for these meetings, which are frequently attended by several hundred farmers. During the season for sugar-making, the sugar experiment station, which has quite recently been moved from Kenner to Audubon Park, New Orleans, is visited by planters from all parts of the world. The average number of visitors at this station during the past season was about one hundred a day.

The influence of the Wisconsin Station within the State has been very marked. Its experiments on pig-feeding are favorably known throughout the whole country. The following extract from a letter from Director Henry indicates some of the other good things which the station has done and is doing: "Years ago the station, then called the Experimental Farm, sent out the Mansury barley, which has been worth a very considerable sum to our people. Last spring, after a year's patient work, our first assistant chemist announced the completion of a method by which an ordinary dairyman, with a reasonable amount of care, can determine the percentage of fat in milk or cream with about as mnch accuracy as the chemist by the gravimetric method. This method of determining fat is being brought into general use by dairymen and others. Last summer our chief chemist, Dr. Babcock, announced the discovery of fibrine in milk, and stated that this new compound played an important part in the raising of cream. Work at the station yet to be announced shows that this discovery is of considerable importance to dairymen, and in it we have an explanation of many of the phenomena of milk and cream."

Similarly favorable reports might be given from stations from Maine to California, and from Alabama to Michigan, wherever the experimenting has been carried on long enough to give a fair test of its value.

Americans have the credit of dropping enterprises which do not pay. It is a significant fact, therefore, that no State which has once established a station has ever abandoned it. On the other hand, the revenues which the stations derive from the States, apart from those which they receive from the National Government, have steadily risen from $2,800, with which the first station began, to more than $125,000 in the present year.

Even if some of the newer stations have as yet brought but little fruit and some that is not well matured, we may confidently expect before many years to have institutions in all the States which will be of the highest service to American agriculture.

One most favorable indication is the earnest desire of the managers of the stations to do the best possible work. This has been particularly manifest at the conventions of the Association of American Agricultural Colleges and Experiment Stations, in which matters of station policy have formed the principal theme of discussion. The underlying thought has uniformly been to learn to do what will best serve the interests for which the stations are established.

The experiment-station enterprise is now equipped for its great work. From its small beginning, fourteen years ago, it has grown out to the farthest limits of our land, has enlisted the best colleges and universities and the ablest investigators of the country, and secured both State and National resources for its service. It has the favor not only of leading minds in science and education, but also of a great army of practical farmers, to whom it has already brought substantial benefits. As the first secretary of agriculture has justly said, "Of all the scientific enterprises which the government has undertaken, scarcely any other has impressed its value upon the people and their representatives in the State and National legislatures so speedily and so strongly as this. The rapid growth of an enterprise for elevating agriculture by the aid of science, its espousal by the United States Government, its development to its present dimensions in so short a period, and, finally, the favor with which it is received by the public at large, are a striking illustration of the appreciation, on the part of the American people, of the wisdom and the usefulness of calling the highest science to the aid of the arts and industries of life. The present is an auspicious time for this undertaking. 'In the history of no nation before have there been such a thirst for knowledge on the part of the great masses of the people, such high and just appreciation of its value, and such wide-reaching, successful, and popular schemes for self-education; no other nation has so large a body of farmers of high intelligence; never before has the great agricultural public been so willing, and indeed so anxious, to receive with respect and use with intelligence the information which science offers; never before has science had so much to give.' The prospects, then, for this, the largest scientific enterprise in behalf of agriculture that any government has undertaken, are full of promise."

The Office of Experiment Stations of the Department of Agriculture.

The number and diversity of problems to be solved in the widely separated sections of our country, the need of linking the stations together, of helping to co-ordinate their efforts, of bringing to them the fruits of accumulated experience, of assisting them in research, and of collating their products and making them available to the public whom they serve, and the evident propriety that the Department of Agriculture should aid the enterprise in these respects, — all these considerations evince the wisdom of Congress in providing for a central office, as a branch of this department, to meet the need.

The stations themselves, through the Association of American Agricultural Colleges and Experiment Stations, were the prime movers in securing the establishment of this office, and have given to it their cordial sympathy and support.

ENEMIES OF THE PLANT-LOUSE.

THE importance of parasitic and predaceous insects in overcoming our insect pests has long been recognized by the practical entomologist. He sees the destroyers swept off as by a flood, and sees in these prolific friends the easy solution of the problem of insect years. He knows, that, were it not for these friends, the destroying hosts would make our earth a desert, and replace plenty with famine. He knows that adversity among these tiny helpers means success to the swarms of insects that devour the crops, and so is rejoiced when he sees these little helpers active and numerous.

The present season has furnished a vivid illustration of this important and interesting fact. On June 30 the heads of wheat in Michigan were crowded with hungry *Aphides*, or plant-lice. These myriad lice, often five or six around a single kernel of wheat, and two hundred on a single head, were sucking the sap and very vi-

tality from the forming kernels. They were rapidly blighting the grain; and, unless some friendly hand were raised against them, the wheat-crop would be utterly ruined. Even then, when the lice were countless in numbers, and when the winged forms were rapidly spreading to the oat-fields, the hand of deliverance was easily discerned in the comparatively few but wondrously prolific enemies of the lice, which had already sounded a halt in the march of destruction. A week later, and the enemies of the lice were in the ascendency; and to-day the lice are nearly exterminated, and the wheat-crop is rescued and the oat-crop saved. Close observation easily demonstrates these truths. Even the careless eye can see the savage insects dining on the lice, or the fatal egg laid which dooms the louse which receives it.

The fact that farmers are noticing these insects friends, and have now an object-lesson which should be rightly understood and carefully studied, leads Professor A. J. Cook, the Michigan State entomologist, to send out a bulletin on the subject of the enemies of the plant-lice. Some weeks ago he was receiving scores of letters asking about the lice: to-day he is receiving as numerous inquiries regarding these friends. That instruction is opportune is evident from such questions as this: "Are these insects going to complete the destruction so actively begun by the lice?"

There are two groups of these insect friends, — predaceous and parasitic insects, — both of which are well illustrated on the heads of wheat of Michigan fields to-day. Predaceous insects are such as devour their prey, much as the cat or weasel devours the mouse. Parasitic insects are those that lay their eggs on or in their victims. When these eggs hatch, the larval parasite proceeds to feast on its host, which thus serves it for both home and food. In the case before us, as soon as the parasite has devoured the viscera of the louse, it uses the skin or crust as a sort of cocoon. These gray, circular cocoons are now thick among the kernels of every head of wheat, and must have been noticed by every observer who has taken pains to examine. A tiny black fly is by far the most important of these little friends that have come to the farmers' rescue, and saved the wheat, barley, and oat crops.

The lice that are the victims of these eager parasities are easily distinguished. They are short, rounded, and gray in color. After the larva disembowels the lice, it uses the dry, thick skin as a cocoon, in which it changes to a pupa. Very soon the mature insect comes forth from a small round hole in the upper, hinder part of the abdomen, and very soon mates, and commences to lay its many eggs in new victims. Of course, these parasitic larvæ fairly swim in the rich nutritious blood of the lice, and so are rapidly developed. Thus we see how it is that the parasites are too much for the lice. Prolific as are the lice, and rapid as they are in development, yet the parasites are even more so, and thus it is that in ten days the parasites have so outnumbered the lice that the latter have been routed and driven from the field. The little flies are just about one-tenth of an inch in length; but, tiny as they are, they will save millions of dollars to the farmers of Michigan and adjacent States during this single year.

The lady-bird beetles are also very active and most efficient aids in the work of ridding the grain-fields of the *Aphides*. Both as larvæ and as mature insects, they feed on the plant-lice, and rapidly deplete their ranks. The beautiful rounded beetles, usually dressed in yellow or orange, and often adorned with black dots and markings, are known and admired by all. Few insects do more good than do these lady-bird beetles. The larvæ of these are elongated, dark-colored insects, usually dotted with gray, yellow, or orange, according to the species. So the insect not only does well, but looks well. There are also four rows of black dots which extend longitudinally, which are easily seen without a glass. Other species of lady-beetle larvæ are duller in color, and so less conspicuous, yet equally active and voracious. If any doubt the good work of these insects, especially the larvæ, he has but to enclose them in a box with louse-infested wheat-heads, or with plant-lice from any plant. The rapid disappearance of the lice will quickly convince the most sceptical of the valuable service of these predaceous friends. These lady-bird beetles are hardly second to the parasite first described, in the work of ridding our grain-fields of the lice. Professor C. M. Weed believes they take a first place in Ohio in this important service.

By close watching in the wheat or oat fields, one may observe a large number of very rapid flying two-winged flies. Not only are these very quick, but many are lined with yellow bands, and are very beautiful. These flies, for food, only sip the sweets from flowers, but they lay their eggs on the plants among the lice, and the maggots that hatch from these are perfect tigers. These syrphus-maggots seem to be véritable gourmands, as the number of plant-lice that one will suck bloodless is surprisingly great. These maggots look some like leeches or blood-suckers. The posterior end is large and truncated, while the mouth end is pointed. The color of the young ones is olive green, while the older or more mature maggots are gray, brown, or purple. There are light-brown transverse bands on the back, and one longitudinal one on each side. These maggots creep along in a slug-like manner, ever reaching into every crevice for the lice. The energetic zigzag motion of the head is very interesting. When it first finds a louse, it stabs him with its sharp mouth-parts, and quickly sucks him bloodless. As the louse shrinks, the maggot swells up. No sooner is one louse victimized than another is seized, and thus these voracious maggots will often destroy a half-score of lice in quick succession. Students have often suggested that these maggots must have India-rubber stomachs. From their great numbers and ravenous appetites, we must conclude that these syrphus-maggots are little, if any, behind the Braconid fly and the lady-bird beetles in their good services in helping to save the grain-crops.

Then the chrysopa-flies, with their beautiful green lace wings and their brilliant golden eyes, are no mean factor in this warfare against plant-lice. The handsome flies do not feed on the lice, but the larvæ do; and, as they have insatiable appetites, they do excellent execution. These flies lay their minute white eggs on the ends of short hairs attached to wheat-stems, twigs of fruit-trees, in short, to any plant that is harboring plant-lice. The larvæ have strong, sharp jaws, and have well earned the name "aphis-lion," which has been aptly applied to them. These and the syrphus-fly maggots work in confinement, or while we are holding the aphis-infected plant in our hand. The Braconid fly and the lady-bird beetles, on the other hand, are more timid and quite easily disturbed; and so, to see them at work, we must approach them with care, and handle them without the least jar. Thus in these beneficial insects Professor Cook describes the little friends that have come to the aid of the farmers, and banished disaster.

BOOK-REVIEWS.

A Practical Guide to the Climates and Weather of India, Ceylon and Burmah and the Storms of the Indian Seas. By HENRY F. BLANFORD, F.R.S. London, Macmillan. 8°. $3.50.

THE leisure following Mr. Blanford's retirement from the meteorological department of the government of India, which was developed in his charge, has been employed in preparing a general account of the climates and weather of that vast empire; and students of meteorology the world over are to be congratulated on having such a work from so competent a hand.

The book is divided into several parts. Part I. treats of the elements of climate and weather, with particular reference to their Indian features, under such headings as "Temperature," "Barometric Pressure and Wind," "Dampness and Dryness," "Clouds, Rain, and Storms." Here we recognize the same simple directness of statement and rational physical explanation of processes that characterize the author's "Indian Meteorologists' Vade-Mecum." The second part treats of the climatic divisions of the peninsula, giving a brief description of the several areas, such as the hills, — under which respectable mountain-ridges of 5,000 to 7,000 feet are included, — the plains, the plateaus, and the coasts. This is followed by an account of the weather-maps issued daily from Simlá on the basis of nearly one hundred telegraphic reports, the storms of the Indian seas, and the relation of Indian rainfall to water-supply and drainage. Several appendices contain tabular climatic statistics for 92 stations, lists of storms in the Bay of Bengal, and rainfall at 114 stations.

It is difficult to select material for extracts where all is so perti-

ment. I shall therefore make further mention only of the cyclones and cyclonic storms concerning which the information is full and important. It may be recalled that Redfield early recognized the general occurrence of cyclonic whirls, seeing that high velocities were in no wise essential in their circulation, and that our ordinary changes of weather and shifts of wind were to be regarded as closely related to the hurricanes of the West Indies and other tropical regions. There has been and still is a conservative hesitation to accept so large a generalization, an illustration of which is commonly seen in the slowness of weather services in general to use such a term as "cyclonic" in connection with the "lows," "areas of low barometer," "barometric depression," "barometric minima," and other paraphrases in current use. The demonstration of the occurrence of relatively gentle cyclonic storms in India, and at seasons hitherto regarded as exempt from them, is therefore of particular interest not only as a fact, but also in the historic development of the science.

As regards the cyclones themselves, little is here said in the way of theory. For that the reader should go to the excellent studies on individual cyclones, chiefly by Eliot, in the memoirs of the Indian meteorological department. But the incurvature of the storm winds is clearly stated; and, while full justice is done to the tireless labors of Piddington in earlier decades, the errors into which he was led by following the "eight-point rule," or circular theory of storms, are explicitly pointed out. The true seasons of occurrence, the relative rarity of these storms, their extreme violence, their tracks and moderate progressive velocity, their general failure to cross even the southern point of India, and the advances lately made in announcing their approach, are all well treated. Until within a few years, it was only the violent cyclones of the May and October seasons, originating on the Bay of Bengal, that were understood when Indian cyclones were mentioned; but with the establishment of a system of observing stations, and, still more, with the preparation of daily weather-maps, it has become apparent that cyclonic storms occur in India at other months also, and of moderate intensity. Blanford recognizes the essential identity of the two in origin and constitution; but he thinks it advisable to distinguish them as cyclones proper and cyclonic storms, in order to avoid misapprehension as well as to emphasize their differences. While the former are practically limited to the late vernal and autumnal months, and not more than two violent ones occur in an average year, the latter occur in frequent succession all through the rainy summer monsoon, and also bring the winter rains to northern India. Curiously enough, the cyclonic storms of summer advance toward some point between west and north, while the winter storms move eastward, or even a little south of east. Here is certainly a new characteristic of this interesting region, and, as far as I know, it is not matched in any other part of the world. It is presumably an effect of alternation from a torrid to a temperate position in the general circulation of the atmosphere. Two of these storms are illustrated by weather-charts of several successive days, in which the central barometric depression and the general spiral movement of the surface winds are clearly indicated. In one of the winter cyclonic storms — that of late January, 1883 — there was a distinct sequence of weather changes with the eastward advance of the storm-centre, precisely of the kind that we know so well in these latitudes,— in the front, warm, damp, southerly winds, clouds, and rain or snow; in the rear, north-westerly winds, clear sky and low temperature, a veritable "cold-wave," giving some hill stations their lowest thermometric records. If this sort of thing is typical of Indian winters, it is likely that our term "cold wave" will go into use there, as their term "cyclone" has come to be so valuable with us.

Again, as to the conditions permitting rainfall. While it is understood that rain often occurs independently of cyclonic conditions, — as, for example, the diurnal summer rains of Florida or of mountain-peaks, — it appears, from the weather-maps of this country and Europe, that most of our precipitation is cyclonic, either in widespread rains or snows, or in local thunder-showers, whose opportunity is in good part dependent on cyclonic winds and contrasts of temperature thus induced. Now, the same thing appears in India. Rain there also may be independent of cyclones and cyclonic storms, as at Cherrapunji, on the foot-hills of the Himalaya north of the Bay of Bengal, where the annual rainfall is nearly fifty feet deep, where from April to September there are on the average twenty-five rainy days in a month, and where 40.8 inches of rain have been collected in twenty-four hours (June 14, 1876). Here much of the rain may be "topographic," a re-action of the mountains on the winds; but, as a rule, Indian rainfall is, like ours, cyclonic. The "bursting of the monsoon" is an accompaniment of a summer cyclonic storm; and the alternation of rain, showers, and occasional rainless days in July and August, is but the expression of the passage of a series of summer cyclonic storms. This gives an entirely new aspect to the monsoon rains. All the excessively heavy rains, for which northern India is remarkable, are cyclonic rains, even though recognizable in their true character only when synoptic weather-charts are constructed.

Sind, a dry district in the far north-west, with an annual rainfall only from five to ten inches, and with only from thirteen to thirty rainy days in the year, also is dependent on the cyclonic storms. Rain falls only when, in the summer monsoon, a cyclonic storm comes in from the eastward, and travels as far as Sind before it is broken up; or when, in the winter, one forms in Sind, or passes eastward across it from Baluchistan.

This is certainly a most significant extension of Redfield's acute suggestion. Disturbances in the general atmospheric circulation tend to take the form of convectional whirls, and give forth rain. If the conception of the whirl is rigid and artificial, it will be of little advantage; but if it admit the unsymmetrical irregularities so abundantly illustrated on our weather-maps, it must come to be one of the most significant generalizations that meteorology has brought forth.

Recalling what the meteorological department of India has become under Mr. Blanford's direction, and remembering the high value of his writings on meteorological subjects, we can but wish that his future leisure might be directed to a general work on meteorology, of scope as broad as Schmid's "Lehrbuch," but with the statistical flavor of that book replaced by the physical flavor that characterizes modern meteorology. There is no such work in English, although such a work would have many English readers.

W. M. D.

Numbers Universalized: An Advanced Algebra. By DAVID M. SENSENIG. New York, Appleton. 12°.

THIS volume will eventually form the first part of a higher algebra, soon to be completed, being intended as an advanced elementary algebra. The object in issuing it separately, as we are informed in the preface, is "to meet the wants of such schools as have arranged a higher course in algebra than is outlined and treated in the author's first book, 'Numbers Symbolized,' and yet have not time enough to devote to this branch of mathematics to complete a full course in higher algebra." The book is well adapted to meet the requirements of schools in which students are prepared for entering college, as well as of advanced classes in high and advanced schools.

In his treatment of the subject, the author, who is professor of mathematics in the State Normal School at West Chester, Penn., has aimed to carefully keep intact the logical sequence of thought, avoiding unnecessary difficulties in the discussion, on the one hand, and too great simplicity, on the other. The definitions are well arranged, and concisely expressed in language unusually simple and exact; and illustrations are given only when required by concepts not sufficiently clear without them. The work as a whole is in line with the best school methods now in use, and should be acceptable to students as well as teachers.

AMONG THE PUBLISHERS.

THE supplement to *Harper's Weekly* of July 24 is devoted to the progress made in electric lighting in New York City, the subject being ably treated by Schuyler S. Wheeler, electric expert of the Board of Electrical Control. Mr. Wheeler discusses and explains the subject under the heads of "Generating and Distributing," "Lamps," "Systems of Distribution," "The Alternating Current," and "Construction of the Lines." The article is fully illustrated.

— Frederick Warne & Co. have just issued a "dollar" Shakspeare, printed from readable type on paper of good quality, and neatly bound in cloth.

— D. Lothrop Company have just ready "Around the World Stories," by Olive Risley Seward, an account of curious things met with in her travels; "Dear Old Story-Tellers," by Oscar Fay Adams, brief biographies of popular story-writers from Æsop to Laboulaye; and "Our Asiatic Cousins," by Mrs. A. H. Leonowens, a description of life in the remotest parts of the East.

LETTERS TO THE EDITOR.

A Possible Elephant.

WHILE examining the bluffs along the Missouri, near Vermillion, Dak., recently, I came upon the remains of what I take to be *Elephas Americanus*. The bones found all belong to the upper and back portions of the skull, and include most of the upper jaw, containing about a third of the right tooth and all of the left, portions of the tusk tubes, enough of the occipital to give both articulating surfaces connecting the skull with the spinal column, and many fragments of the upper portion of the skull. The perfect tooth weighs about twelve pounds, as near as can be determined without detaching it from the jaw.

The bones are nearly all in a fine state of preservation. Only a small portion of one tusk was found, and that much decomposed. Judging from the tubes, the tusks could not have been less than six inches in diameter.

The bones lay in a bed of sand and fine gravel (probably Champlain) about twenty feet thick. This sand rests directly upon the Fort Benton clays, and is overlaid by one hundred feet of loess. The *Elephas* bones were near the bottom of the sand, and about one hundred feet above the river. They were exposed by a landslide which carried down with it all of the skeleton except the portion of the skull mentioned. G. E. CULVER.

Vermillion, Dak., July 29.

Are Beech-Trees ever struck by Lightning?

ON p. 50 of *Science* for July 19, I notice an article on lightning striking beech-trees. The following instance has come to my notice. In the summer of 1887 Marcus Grover was at a sawmill in Rome, Ashta. County, O. Noticing an approaching storm, he, as he supposed, thoughtfully hitched his two-horse team to a small green beech-tree which stood in the mill-yard. During the storm came a sharp crash of thunder and lightning.

Mr. Grover looked for his team, only to find both horses dead. There were some small holes in the ground, and the hair was scorched a little, but no trace of lightning could be found on the tree. E. E. BOGUE.

Orwell, Ashta. Co., O., Aug. 2.

Mosquitoes and Science.

REFERRING to the letter of Dr. R. H. Lamborn, on p. 85 of *Science* for Aug. 2, there would seem to be a choice between two evils. I cannot now lay my hand on the article referred to, but recall the fact that the larvæ of mosquitoes were found to be potent agents in diminishing malarial exhalations from stagnant water. The question arises whether it would be better to endure malaria or mosquitoes. EDWARD H. WILLIAMS, jun.

Bethlehem, Penn., Aug. 5.

Queries.

46. FERN'S NAME. — I send you a small fern which grows in this section of the country, and is said to be a rare specimen. Will you please publish in your *Science* the name of this fern? WALTER W. FRANCIS.

Idaho Springs, Col., July 23.

Answers.

46. FERN'S NAME. — The name of the fern submitted for determination is *Nothoclæna Fendleri*. At Idaho Springs, Col., it has probably been collected near its northern limit, the species being much more abundant farther south. E. J. N.

INDUSTRIAL NOTES.

Standard Resistance Box and Bridge.

MESSRS. JAMES W. QUEEN & CO. call the attention of electricians to the following indorsement of their No. 1 Standard laboratory resistance box and bridge. The set referred to in a letter from Professor B. F. Thomas, an extract from which we give below, was designed by Professor William A. Anthony, and was constructed under his personal supervision by the Mather Electric Company. By a special arrangement, all these sets are now made by Messrs. Queen & Co. Professor Anthony adjusts all of the coils, and furnishes a certificate with each set.

Professor Benjamin F. Thomas of the Ohio State University writes from Columbus, O., May 18, 1889, concerning this new resistance set, "The mechanical work on it is, if any thing, superior to that of Elliott Brothers. The metal segments are uniform in size and shape, and well finished, while the fit of the plugs is the most perfect I have seen. The coils are of one lot of wire throughout, and have therefore a uniform temperature co-efficient, whose low value, .00024, allows one to neglect it in all ordinary work. The box is adjusted to legal ohms at 19° C., and is accompanied by Professor Anthony's statement that they are accurate to $\frac{1}{50}$ of 1 per cent. . . . You will remember that you procured for me while at the University of Missouri a large five-dial bridge from Elliott Brothers. That was a fine piece of apparatus, but I regard this as far superior. It has all the advantages of the dial arrangements, and has in addition the advantage of the possible connection of any single coil, or of almost any desired combination of single coils, and also of any desired combination in parallel. One can therefore check the adjustments of the several coils against one another, the box thus containing means for its own verification. The box answers also the purpose of a set of comparison coils, and enables one to do a number of things which cannot be done with the usual forms."